BRITISH STANDARD 514 : 1933

Baking Insulating Varnish

(BITUMEN TYPE) FOR ELECTRICAL PURPOSES

BRITISH STANDARDS INSTITUTION

BRITISH STANDARD SPECIFICATION

BAKING
INSULATING VARNISH
(BITUMEN TYPE)
FOR ELECTRICAL PURPOSES

B.S. 514 : 1933

Price 3/- net

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CO-OPERATING ORGANISATIONS

The Electrical Industry Committee[†] under whose supervision this Specification was prepared consists of representatives from the following Government Departments and Scientific and Industrial Organisations:

*Admiralty.
Central Electricity Board.
Electricity Commissioners.
*General Post Office.
*Home Office.
H.M. Office of Works.
High Commissioner for India.
*National Physical Laboratory.
*War Office.
Association of Consulting Engineers.
*British Electrical and Allied Manufacturers' Association.
*British Electrical and Allied Industries Research Association.
Cable Makers' Association.
Electrical Contractors' Association (Incorporated).
Electric Lamp Manufacturers' Association.
Incorporated Association of Electric Power Companies.
Incorporated Municipal Electrical Association.
Institution of Electrical Engineers.
London Electricity Supply Association.
Municipal Tramways and Transport Association.
Provincial Electric Supply Association.
*Railway Companies of Great Britain.
Tramways, Light Railways, and Transport Association.

The Government Departments and Scientific and Industrial Organisations marked with an asterisk in the above list, together with the following, were directly represented on the Committees entrusted with the preparation of this Specification:

Air Ministry.
Government Laboratory.
London Chamber of Commerce.
National Federation of Associated Paint, Colour and Varnish Manufacturers of the United Kingdom.
Oil and Colour Chemists' Association.
Research Association of British Paint, Colour and Varnish Manufacturers.

[†] The Electrical Industry Committee is the British National Committee of the International Electrotechnical Commission.

THIS SPECIFICATION having been approved by the Electrical Industry Committee and endorsed by the Chairman of the Engineering Divisional Council, was published by the authority of the General Council as a British Standard on 20th November, 1933.

First published : November, 1933.

This Specification was reprinted in new type in June, 1941. The text is identical with that of previous copies of the 1933 edition but the page numbering may not always be identical.

The Institution desires to call attention to the fact that this Specification is intended to include the technical provisions necessary for the supply of the material herein referred to, but does not purport to comprise all the necessary provisions of a contract.

In order to keep abreast of progress in the industries concerned, the British Standards are subject to periodical review. Suggestions for improvements will be recorded and in due course brought to the notice of the Committees charged with the revision of the standards to which they refer.

A complete list of British Standards, indexed and cross-indexed for reference, will be found in the Institution's Yearbook.

This Specification includes a reference to the following British Standard :

No. 188. Determination of Viscosity in Absolute Units.

BRITISH STANDARD SPECIFICATION FOR
BAKING INSULATING VARNISH
(BITUMEN TYPE)
FOR ELECTRICAL PURPOSES

FOREWORD

This Specification is based on information supplied by the British Electrical and Allied Industries Research Association, which Association has carried out extensive research and has developed many of the methods of testing given herein. The limits given have been adopted after considerable investigation of existing varnishes.

Investigations are in progress with a view to the preparation of British Standard Specifications for other classes of insulating varnish.

A British Standard Specification for Clear Baking Oil Insulating Varnish has already been published (B.S. 119).

SPECIFICATION

SCOPE

1. This Specification covers baking insulating varnish (bitumen type) giving a finished film which shall be flexible, moisture-resisting and capable of withstanding vibration without chipping or cracking.

The varnish shall be suitable for the impregnation of coils, including those of electric traction plant, and for use in any situation where apparatus is subjected to vibration.

Before the varnish is suitable for certain uses it may be necessary to thin it, after delivery, with a suitable solvent as recommended by the varnish manufacturer.

The varnish shall be free from suspended solid matter.

FINISH

2. The varnish shall produce a uniform, smooth, glossy surface when dried on specimens prepared for the drying-time test in accordance with the method described in Appendix II.

VOLATILE MATTER

3. The amount of volatile matter, when the varnish is tested as described in Appendix I, shall not exceed 50 per cent computed on the original weight of the varnish, unless otherwise agreed between the purchaser and the supplier.

SPECIFIC GRAVITY

4. The value of the specific gravity (at 20°C.) of the varnish, as delivered, referred to water at the same temperature, shall be the subject of agreement between the purchaser and the supplier.

The value of the specific gravity of the varnish, after the addition of the required amount of extra solvent, shall also be subject to agreement between purchaser and the supplier in cases in which the varnish has to be thinned after delivery before being suitable for certain uses.

The specific gravity of the varnish shall not vary from the agreed value by more than plus or minus 0·01.

VISCOSITY

5. The value of the viscosity of the varnish at 25°C. shall be the subject of agreement between the purchaser and the supplier.

The value of the viscosity of the varnish after the addition of the required amount of extra solvent shall also be subject to agreement between purchaser and supplier in cases in which the varnish has to be thinned after delivery before being suitable for certain uses.

The viscosity of the varnish shall not vary from the agreed value by more than plus or minus 25 per cent when determined as described in B.S. 188, ‘Method for the Determination of Viscosity in Absolute Units.’

DRYING TIME

6. The time required for the varnish to dry, when determined as described in Appendix II, shall not exceed 8 hours for the first coat. When necessary, the type and proportion of thinner recommended by the varnish maker shall be used to thin the varnish to the agreed specific gravity or viscosity (see Clauses 4 and 5) before applying the test.

ELECTRIC STRENGTH AT 90°C.

7. The electric strength at 90°C. of the varnished paper shall be not less than the appropriate value shown on the curve in Fig. 1, when the paper is prepared and the electric strength determined as described in Appendix III.

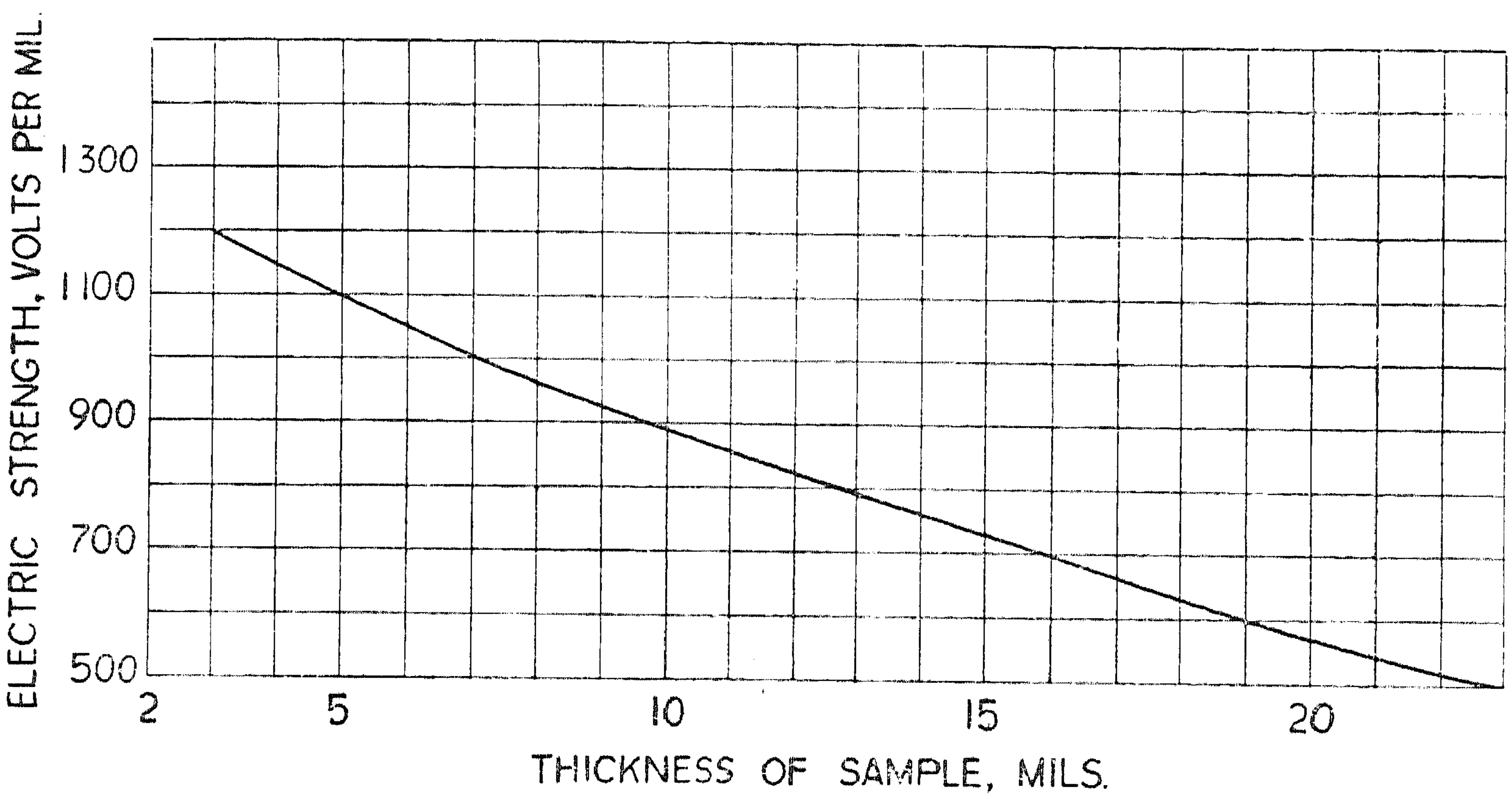

Fig. 1. Electric Strength at 90°C.

RESISTANCE TO MOISTURE

8. The resistance to moisture shall be determined by an electric strength test on varnished paper at 20°C. after it has been subjected to the damp atmosphere described in Appendix IV.

The electric strength of the varnished paper, when determined as described in Appendix IV, shall be not less than 500 volts per mil.

AGEING

9. The varnish shall show no sign of cracking, when tested as described. in Appendix V, after being heated at a temperature between 115°C. and 120°C. for 100 hours

ACIDITY OR ALKALINITY OF VARNISH FILM

10. The *p*H-value of the varnish film, when determined as described in Appendix VI, shall be not less than 3·8 nor more than 7·5.

FLASH POINT

11. The closed flash point of the varnish as received shall be not less than 23°C. (73°F.) except by agreement between the purchaser and the supplier.

The closed flash point of the varnish shall be tested in the Abel apparatus.

APPENDIX I

METHOD FOR THE DETERMINATION OF VOLATILE MATTER

One or two grammes of varnish shall be weighed quickly into a tared flat-bottomed dish of glass or aluminium, about three inches in diameter. The dish shall be heated on a hot water bath to drive off most of the thinners and then placed in an air oven at 105°C. (± 5°C.) and heated for about one hour. The dish shall be cooled, weighed and returned to the oven for further heating. The weight shall be taken after each half-hour of re-heating and that weight taken as final when there is no alteration or an increase occurs due to oxidation.

APPENDIX II

METHOD FOR THE DETERMINATION OF DRYING TIME

If the varnish is supplied ready for use without thinning, it shall be tested as received. If it has to be thinned before use, sufficient quantity of a suitable solvent, recommended by the varnish maker, shall be added until the specific gravity or viscosity reaches the agreed value. Sheets of tissue paper, as specified below, approximately 8 in. square, shall be completely immersed in the varnish for approximately one minute, care being taken to remove all froth. The depth of the varnish in which the specimen is immersed shall be about $\frac{3}{4}$ in. The specimen shall be drawn through the varnish at the same rate as the excess of varnish slips from the surface of the specimen and then allowed to drain at room temperature (approximately 20°C.) until dripping ceases. To prevent the paper crinkling, it may be found convenient to attach a clip to the top and to the bottom of the specimen before immersion in the varnish, the clips being left in position during the drying period. The varnished specimens shall be dried as follows:

The varnished specimens shall be dried in an oven at a temperature between 95°C. and 100°C. unless the varnish maker recommends a higher temperature. If the oven is not heated electrically, it shall be heated externally in such a manner that the products of combustion do not enter the oven. The air content of the oven shall be changed not less than three times per hour.*

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* A suitable method for changing the air is to insert a tube in the oven and connect it to a water vacuum pump.

The varnish shall be considered to be dry when it passes the following test:

A circular piece of No. 4 Whatman filter paper, 1⅜ in. diameter, shall be applied approximately to the centre of the specimen. The filter paper shall be pressed on to the varnish film by a weight of 1 lb., the surface of the weight in contact with the paper being a circular plane 1 inch in diameter. The test shall be carried out at a temperature between 15°C. and 25°C. The filter paper shall not adhere to the varnish film.

For the purpose of the electric-strength test (Appendix III) the specimens shall be again dipped in the varnish at the conclusion of the test for drying time. When being dipped, drained and dried this second time, the specimens shall be suspended in the opposite direction to that employed for the first film, as described above.

*Specification for Tissue Paper.**—The tissue paper shall be made from sulphite wood pulp, and shall be approximately one mil thick.

The weight of the paper shall be not less than 14 grm. per square metre.

The electric strength (rapidly applied value) in air at 90°C. shall be not less than 200 volts per mil.

The *p*H-value shall be not less than 6 and shall not exceed 8 when determined as follows:

Two grammes of the paper are cut into strips about 1 in. by ⅛ in. and are put into a 100 ml. round-bottom flash, 100 ml. of neutral CO_2-free water are added and the water is raised to boiling over a flame arranged not to char the paper. Boiling is continued for 5 minutes and the water is cooled. The water is decanted and its *p*H-value is determined either potentiometrically or by means of indicators.

The amount of ash when determined as described below shall not exceed 2 per cent.

The test for ash shall be carried out as follows:

Not less than ten grammes of paper shall be dried at a temperature of 105°C. for three hours and then weighed with the usual precautions to obtain the dry weight of the paper. The sample shall be ignited to constant weight in a muffle furnace at a temperature between 650°C. and 700°C., with all precautions against loss. Care must be taken to ensure the absence of unburnt carbon in the ash. The residue of incombustible matter (ash) shall be weighed and the amount, computed as a percentage on the weight of the dried sample, shall not exceed the value given above.

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* Information as to where suitable tissue paper can be procured may be obtained on application to the Director, British Standards Institution.

APPENDIX III

METHOD FOR THE DETERMINATION OF ELECTRIC STRENGTH AT 90°C.

The electric strength test shall be carried out on varnished sheets of tissue paper which shall comply with the specification given in Appendix II. The paper shall be varnished and dried twice as described in Appendix II.

The electric strength test shall be carried out in air at a temperature of 90°C. (± 2°C.), preferably within half-an-hour of the completion of the drying of the second coat of varnish. If this is impracticable, the test shall be carried out within 24 hours and the specimen shall be heated at a temperature of 90°C. (± 2°C.) for half-an-hour immediately before the voltage is applied.

The top electrode shall be a solid cylinder of brass, 1½ in. diameter and 1½ in. high. The bottom electrode shall consist of a flat disc of brass 3 in. diameter and 1 in. thick. The sharp edges shall be removed from the electrodes, but the radius at the edge shall not exceed 1/32 in. The electrodes shall be raised to the test temperature before the specimen is placed in position, and it shall be maintained at the test temperature for not less than one minute and not more than five minutes before the voltage is applied. The temperature shall be measured by a thermometer inserted in a hole in the top electrode and reaching to within half-an-inch of the bottom.

The test-voltage shall be applied between the electrodes, and the test shall be carried out as follows:

The test shall be made with alternating voltage at a frequency of about 50 cycles per second. The test-voltage shall be of approximately sine-wave form, and during the application of the test the peak value, as would be determined by oscillograph, or other approved method, shall be not more than 1·45 times the R.M.S. value. The R.M.S. value of the applied voltage shall be measured by means of a suitable voltmeter connected to the output side of the testing-transformer, by means of a voltmeter used with a suitably calibrated voltage transformer, or by means of a voltmeter used in connection with a special calibrated voltmeter winding on the testing-transformer.

The test-voltage shall be raised at a uniform rate from zero to the breakdown voltage at such a rate that the specimen is punctured in about 10 seconds from the time that the voltage is applied.

The thickness of the specimen shall be determined from the mean of three measurements of thickness taken as close to the point of puncture as practicable. The mean value shall be used in computing the breakdown voltage per mil.

Ten puncture tests shall be made and the breakdown volts per mil shall be computed in each case. The mean value of the breakdown volts per mil shall be deemed to be the electric strength of the varnished paper.

APPENDIX IV

METHOD FOR THE DETERMINATION OF RESISTANCE TO MOISTURE

The electric strength test for resistance to moisture shall be carried out on varnished paper similar to that used for the test described in Appendix III.

Immediately after the second coat of varnish is dry the specimens shall be subjected for 24 hours to a controlled atmosphere of relative humidity not less than 95 per cent at a temperature between 15°C. and 25°C. This relative humidity can be obtained by the use of an air-tight enclosure containing a large surface of water, the enclosure being lagged to prevent rapid changes in temperature. The electric strength shall then be determined at 20°C. as described in Appendix III, whilst the specimen is in the controlled atmosphere.

APPENDIX V

METHOD FOR THE DETERMINATION OF AGEING

If the varnish is supplied ready for use without thinning, it shall be tested as received provided that the required thickness of film can be obtained with not fewer than two coats. If the varnish has to be thinned before use, a sufficient quantity of a suitable solvent recommended by the varnish maker shall be added, until the specific gravity or viscosity reaches the value agreed upon for this test (Clauses 4 and 5).

The ageing test shall be carried out on a strip of varnished copper foil 10 mils thick and about 6 in. by 2 in. The foil shall be sufficiently flexible to withstand, without cracking, 30 bends (15 in each direction) round a rod $\frac{1}{8}$ in. diameter, using an apparatus of the type shown in Fig. 2. The surface of the foil must be free from grease, and this can be secured by rubbing it with cotton wool dipped in benzole.

The varnish shall be applied, to one side of the foil only, by flowing over the clean surface of the foil so as to produce a uniform film. The varnished foil shall be allowed to dry in dust-free air in an upright position for half-an-hour at a temperature between 15°C. and 25°C. It shall then be stoved for two hours at a temperature between 100°C.

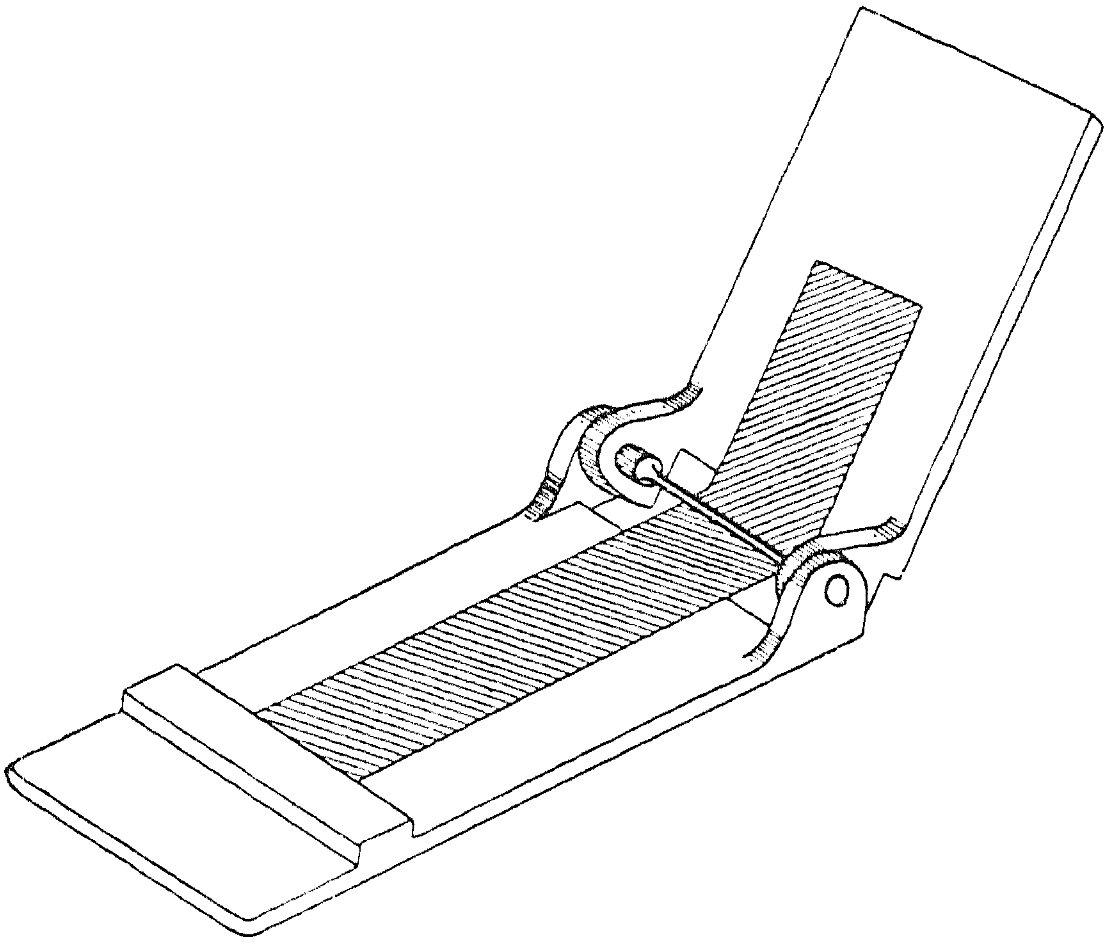

Fig. 2. Apparatus for Determination of Ageing

NOTE. A dimensioned drawing showing details of construction of a suitable form of this apparatus may be obtained on application to the Director, British Standards Institution.

and 105°C. and the air content of the oven shall be changed not less than three times per hour. A second coat of varnish shall then be applied and the specimen shall be drained and stoved as before. When the specimen is being drained and stoved the second time, it shall be placed in the reverse direction to that employed for the first film. On removal from the oven the varnished foil shall be kept for one hour at a temperature between 15°C. and 25°C. and the thickness of the film shall then be measured. The film shall be not less than 5 mils or more than 7 mils thick ; if less than 5 mils further coats of varnish shall be applied as before, the final coat being stoved until the varnish is dry ; the stoving period for this coat shall not exceed eight hours.

The varnished foil shall be heated for 100 hours at a temperature between 115°C. and 120°C., the air content of the oven being changed not less than three times per hour. At the end of this period the varnished foil shall be kept at room temperature (15°C. to 25°C.) for one hour.

The foil, with the varnish film outside, shall be bent double over a rod $\frac{1}{8}$ in. diameter by means of the apparatus shown in Fig. 2, the rate of bending being such that the complete bend of 180 degrees is performed in two seconds. The bending test shall be made at two places on the sample, and shall be carried out at room temperature (15°C. to 25°C.).

NOTE. Some samples of copper foil themselves show minute hair cracks, and, when cracking is observed, care must be taken to ensure it is in the varnish.

APPENDIX VI

METHOD FOR THE DETERMINATION OF ACIDITY OR ALKALINITY OF VARNISH FILM

The test shall be carried out on a sample of the baked film prepared, for example, by coating with the varnish a piece of tinplate amalgamated with mercury. The baking shall be carried out under the conditions detailed in Appendix II. One gramme of the film shall be removed from the plate and transferred to a hard glass tube containing 25 ml. of warm freshly distilled pure water, free from carbon dioxide. The film shall be digested with the water at about 70°C. for one hour, after which the water shall be decanted from the varnish and its *p*H-value measured, at room temperature, either potentiometrically or by a colorimetric indicator method. The latter method may safely be used as a proof test : the requirements of Clause 10 are met if the apparent *p*H-value observed, when bromophenol blue is used, is more than 3·8, and the apparent *p*H-value observed, when phenol red is used, is less than 7·5. If the apparent *p*H-value is found to vary with the indicator selected, the method is not applicable for exact determinations, and a potentiometric method must be employed when definitive values for the *p*H-value are required.

BRITISH STANDARDS INSTITUTION

The British Standards Institution was founded in 1901 and incorporated by Royal Charter in 1929.

The principal objects of the Institution as set out in the charter are to co-ordinate the efforts of producers and users for the improvement, standardization and simplification of engineering and industrial materials; to simplify production and distribution; to eliminate the waste of time and material involved in the production of an unnecessary variety of patterns and sizes of articles for one and the same purpose; to set up standards of quality and dimensions, and to promote the general adoption of British Standards.

In carrying out its work the Institution endeavours to ensure adequate representation of all viewpoints. Before embarking on any project it must be satisfied that there is a strong body of opinion in favour of proceeding and that there is a recognized need to be met.

The Institution is a non-profit-making concern. It is financed by subscriptions from firms, trade associations, professional institutions and other bodies interested in its work, by a Government grant and by the sale of its publications. The demands on the services of the Institution are steadily increasing and can only be met if continuing and increased financial support is provided.

Membership of the Institution is open to British subjects, companies, technical and trade associations, and local and public authorities.

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